Nosocomial Multiply Resistant *Providencia stuartii*: a Long-Term Outbreak with Multiple Biotypes and Serotypes at One Hospital

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A long-term outbreak of urinary tract-associated multiply resistant *Providencia stuartii* occurred in a large medical facility that included a 513-bed chronic care unit. The unique characteristics of this outbreak were that from within a single medical facility, *P. stuartii* with multiple serotypes, biotypes, and antibiograms could be identified. The organisms isolated had five different biotypes, seven different antibiograms, and two major serotypes. All of the organisms were susceptible to amikacin, cefamandole, and cefoxitin. Application of standard infection control measures impeded the spread of this outbreak, and it slowly terminated 16 months later.

*Providencia stuartii* appears to be emerging as a hospital-acquired pathogen in many respects similar to *Pseudomonas aeruginosa* and *Serratia marcescens*. *P. stuartii* has been reported in urinary tract infections, particularly after bladder catheterization (12) and burn infection (13). Recently, the close relationship between *P. stuartii* and *P. rettgeri* has been reported (5, 9). Many organisms that previously have been called *P. rettgeri* only on the basis of urea hydrolysis have been reclassified as *P. stuartii* on the basis of fermentation reactions (5, 9). It is now necessary to review past records on *P. rettgeri* (1, 4) with this new classification in mind. The present communication describes a long-term outbreak of *P. stuartii* originating in a chronic care unit and eventually involving patients throughout the medical center.

**MATERIALS AND METHODS**

All organisms were obtained from specimens submitted to the Clinical Microbiology Laboratory at the North Chicago Veterans Administration Medical Center (NCVAMC). The bacteria were tested for antimicrobial susceptibility by the disk diffusion (2) and the tube dilution methods (11). Identification and biotyping of the organisms were accomplished with the use of the API-20E system (Analytab Products, Plainview, N.Y.). Serotyping was performed as a courtesy by John Penner at the University of Toronto, Toronto, Ontario.

**Background and epidemiology.** The NCVAMC is a medical center with approximately 1,500 beds. This complex has several buildings with different functions, including a chronic care facility (513 beds), one building serves as an acute medical facility (238 beds). Any patient in the other areas with an acute medical or surgical problem is transferred to this unit. Patients are therefore frequently transferred throughout the complex.

The first isolate at NCVAMC of *P. stuartii*, then called *P. rettgeri*, occurred in February 1974, according to the records of the clinical microbiology laboratory. Laboratory records indicate this organism was biochemically a urea-positive *P. stuartii*. The problem came under surveillance by the medical center infection control team in September 1977. At this time there were over 10 new isolates of this organism each month until control measures were initiated. The frequency of subsequent isolates of resistant *P. stuartii* slowly fell to zero over the next 16 months. Environmental cultures obtained during this time period were all negative for *P. stuartii*. Also during this period, the medical center had a considerable number of other multiply resistant gram-negative bacteria, namely *Proteus mirabilis*, *Escherichia coli*, and *Klebsiella pneumoniae*. Our definition of a multiply resistant organism is one that is resistant to any two of the following antimicrobial agents: amikacin, carbenicillin, gentamicin, and tobramycin.

Patients who harbored any multiply resistant organisms in their urinary tract were isolated and treated with wound and skin precautions (3). Patients with urinary catheters were physically separated from one another. These patients were also given red chart covers, and red tags were placed on the head of their beds as a warning to physicians and other hospital employees that these patients harbored resistant bacteria in their urine. Hand washing after contact with the patient was emphasized. Isolation procedures were carried out until three consecutive negative cultures were obtained, 72 h after discontinuing antimicrobial agents.

**RESULTS**

Although over 35 isolates of multiply resistant
P. stuartii were recovered from different patients during the past 12 months, 14 isolates from 10 patients were selected to study in detail. These isolates were arbitrarily chosen on the basis of differing biochemical patterns, susceptibility patterns, or the geographic location of the patient within this medical center. For instance, in one ward of 20 patients, 11 were colonized with P. stuartii. All 11 isolates had the same antibiogram and biotype; therefore, only one was selected for this study. In cases where more than one isolate was from a single culture, recognition was based on different colony morphology in the primary specimen plates.

Five different biotypes were found among these 14 isolates (Table 1). In all cases, biochemical patterns were reproducible. The variable reactions in the biotype were urea, inositol, and sucrose. Two patients had two different biotypes in a single specimen (Table 1, no. 2 and 6), and one patient had one biotype in the urine (Table 1, no. 11); another in the sputum (Table 1, no. 5).

The O serotypes of these isolates showed five different types (Table 1). Two serotypes, O16 and O25, accounted for 71% of all types identified. Sixty percent of these two most common serotypes originated from common geographical sites. Two patients had two different serotypes in a single specimen; one patient had two serotypes in the urine (Table 1, no. 11) and another from the sputum (Table 1, no. 5).

With the disk diffusion method of antimicrobial susceptibility testing, seven different patterns were noted (Table 2). Minimal inhibitory concentrations for each organism were determined for gentamicin, amikacin, cefoxitin, and cefamandole. In all cases, the minimal inhibitory concentrations indicated resistance to gentamicin and sensitivity toward amikacin, cefamandole, and cefoxitin (Table 3).

DISCUSSION

Arroyo et al. (1) and Edwards et al. (4) have reviewed P. rettgeri outbreaks. The latter paper (4) lists the biochemical characteristics of the P. rettgeri isolates in study. With this information, it can be determined that the organism in the latter outbreak was urea-positive P. stuartii (4). Farmer et al. (5) reported a blood culture that grew both urea-positive and urea-negative isolates of P. stuartii. They speculated that the urease production was probably plasmid mediated; however, they did not attempt to show the existence of a plasmid. These reports give reason to review the literature on P. stuartii and P. rettgeri with their similarity in mind.

In the present report, disk diffusion susceptibility studies indicated that all of the strains were susceptible to amikacin, cefamandole, and cefoxitin. Some of the strains were susceptible to other antimicrobial agents; however, none was susceptible to gentamicin, an antimicrobial agent used extensively in this medical center. There is a report on emergence of gentamicin-resistant P. stuartii during therapy with gentamicin (6). The minimal inhibitory concentrations of gentamicin, amikacin, cefamandole, and cefoxitin agreed with the disk diffusion results. The two new broad-spectrum cephalosporins, cefamandole and cefoxitin, may be useful alter-

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**Table 1. Characteristics of selected isolates of P. stuartii**

<table>
<thead>
<tr>
<th>Culture</th>
<th>Site</th>
<th>Biochemical variables</th>
<th>Serotype*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Urea</td>
<td>Inositol</td>
</tr>
<tr>
<td>Blood</td>
<td></td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>2</td>
<td>Blood</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2a*</td>
<td>Urine</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>3</td>
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<tr>
<td>4</td>
<td>Urine</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>5</td>
<td>Sputum</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>6</td>
<td>Urine</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
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<td>Urine</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>7</td>
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<td>-</td>
<td>+</td>
</tr>
<tr>
<td>11</td>
<td>Urine</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>11a*</td>
<td>Urine</td>
<td>+</td>
<td>-</td>
</tr>
</tbody>
</table>

* Data courtesy of John Penner.

* Rough variant.

* Second isolate from specimen.
The unique characteristics of this outbreak are that multiple serotypes, multiple biotypes, and multiple antibiograms were seen. Occasionally, two serotypes or two biotypes were seen in a single specimen. Since P. stuartii is not a common hospital isolate, it seems unusual that this many serotypes and biotypes could be seen in any particular outbreak; however, Penner et al. (8) reported multiple O serotypes in all of the P. stuartii studied from 12 different hospitals. Biotype and serotype information has been successfully used in the epidemiology of S. marcescens (7), and serotyping has been useful with P. aeruginosa (10). Our information on serotyping and biotyping has not been useful in studying this long-term outbreak. However, this information was useful in specimens obtained in common geographical areas. We can speculate that either several different isolates were introduced into different areas of the hospital or the organism has been able to change serotypes and biotypes via some method such as a plasmid or mutational event. Other organisms such as E. coli, P. mirabilis, and K. pneumoniae, also multiply resistant, have been often isolated from the same specimen as P. stuartii, further supporting a possible plasmid transfer. We have recently successfully transferred an antimicrobial resistance plasmid from P. stuartii (no. 8) to a susceptible strain of E. coli (unpublished data).

The reservoir of the organism seems to be the infected patient. Several of the patients harbored the organism on their skin, throat, or fecal material as determined by routine cultures. This was in contrast to the work of Wenzel et al., who were unable to isolate the organism from stool cultures and only once from a throat culture among 14 patients sampled (13). Since the control measures were initiated in the spring of 1978, only one new patient with resistant P. stuartii has been seen. This patient has been on one of the wards that contains several patients with resistant P. stuartii; however, this patient was not cultured in the past. New acquisitions of P. stuartii decreased, and no new isolates have been seen since January 1979.

## LITERATURE CITED


